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Mechanical Control of Tissue Morphogenesis

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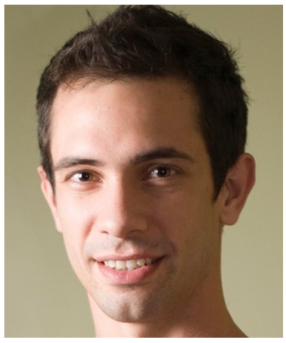
ABSTRACT

The sculpting of tissues into their functional morphologies requires a tight spatiotemporal control of their mechanics. While cell-generated mechanical forces power morphogenesis, the resulting tissue movements strongly depend on the local tissue mechanical (material) properties, as these govern the system's response to the internally generated forces. Despite their relevance, the specific roles of mechanical forces and mechanical properties in tissue morphogenesis remain largely unknown, mainly because of a lack in methodologies enabling direct in vivo and in situ measurements of cell-generated forces and mechanical properties within developing 3D tissues and organs. In this talk, I will present two microdroplet-based techniques that we have recently developed to quantify both local cellular forces and mechanical properties within developing 3D tissues. Focusing on body axis elongation in zebrafish, I will show that spatial variations in supra-cellular (tissue level) stresses, and especially in tissue mechanical properties, control the morphogenetic movements necessary to shape the embryonic axis. In contrast, the magnitude of cellular forces is largely uniform in the tissue. Overall, our results indicate that spatiotemporal variations in tissue mechanical properties, rather than cellular forces, regulate the sculpting of embryonic 3D tissues.

BIO:



Otger Campàs is an Assistant Professor in the Mechanical Engineering department at UCSB, where he holds a Mellichamp Chair in Systems Biology. His research group combines theoretical and experimental methods to approach a variety of problems related to morphogenesis and self-organization of living matter. Specifically, his group focuses on how mechanical signals control the shaping of embryonic tissues and organs. Before arriving at UCSB in July 2012, he was a postdoctoral fellow at Harvard University, working with Professors Brenner, Mahadevan and Ingber. Campàs received his B.S. in Physics from the University of Barcelona, and completed his Ph.D. in Biophysics at the Institut Curie (Paris), working under Jacques Prost, Jean-François Joanny, and Jaume Casademunt, studying how cellular movements and cellular organization arise from the molecular forces generated by motor proteins and polymerization of cytoskeletal filaments. In 2008 he spearheaded a highly popular event titled “Cooking and Science with Ferran Adrià” at Harvard University, and was later co-founder of the "Science and Cooking" course and lecture series at Harvard University. For more information about his research please visit https://campas.me.ucsb.edu.